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(71) Applicant: **MITSUBISHI JUKOGYO KABUSHIKI KAISHA**
5-1, Marunouchi 2-chome Chiyoda-ku
Tokyo(JP)

(72) Inventor: **Irie, Yasutaka, c/o Yokohama Dockyard, Machin.Wrks**
Mitsubishi Jukogyo K.K., 12, Nishiki-cho
Naka-ku, Yokohama, Kanagawa Pref.(JP)
Inventor: **Ono, Shigemi, c/o Yokohama Dockyard, Machin.Wrks**
Mitsubishi Jukogyo K.K., 12, Nishiki-cho
Naka-ku, Yokohama, Kanagawa Pref.(JP)
Inventor: **Kunimoto, Etsuo, c/o Nagasaki Techn. Inst.**
Mitsubishi Jukogyo K.K., 1-1, Akunoura-machi
Nagasaki, Nagasaki Pref.(JP)
Inventor: **Tosa, Youzou, c/o Nagasaki Techn. Inst.**
Mitsubishi Jukogyo K.K., 1-1, Akunoura-machi
Nagasaki, Nagasaki Pref.(JP)
Inventor: **Nagae, Yoshinori, c/o Nagasaki Techn. Inst.**
Mitsubishi Jukogyo K.K., 1-1, Akunoura-machi
Nagasaki, Nagasaki Pref.(JP)

(74) Representative: **Meissner, Peter E., Dipl.-Ing. et al**
Patentanwaltsbüro Meissner & Meissner,
Herbertstrasse 22
W-1000 Berlin 33(DE)

(54) High pressure oil generating apparatus of internal combustion engine.

(57) The present invention relates to a high pressure oil generating apparatus of an internal combustion engine for driving valves or devices installed in the internal combustion engine with working oil. The construction consists of a cam having one and more lobes fixed to a crank shaft as one body, one and more jerk type high pressure pumps operated by the cam, a working oil source for feeding working oil to the high pressure pumps, an accumulator for accumulating high pressure working oil discharged from respective high pressure pumps and a control means, and is characterized in that the rack positions of above-mentioned respective high pressure pumps are adjusted and the working oil pressure is controlled at a predetermined pressure by the control means.

Thus, the high pressure oil generating apparatus is applied practically for controlling the fuel injection quantity of the internal combustion engine and for controlling a suction/discharge valve, and particularly for controlling operation of a discharge valve.

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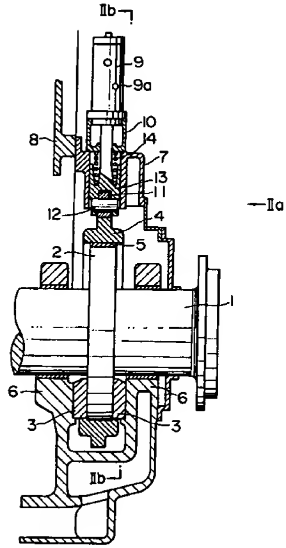
F I G. 1



2. FIELD OF THE INVENTION AND RELATED ART STATEMENT

The present invention relates to a high pressure oil generating apparatus which drives a fuel injector, an exhaust valve and the like with oil pressure.

A conventional high pressure oil generating apparatus is described in Japanese Patent Application Laid-Open No.59-173512(No.173512/1984)for instance. This apparatus is composed of a working oil feeding pump, a filter, a working oil tank pressure regulating valve and an accumulator. The working oil feeding pump is driven by an engine through a belt.

In above-mentioned conventional high pressure oil generating apparatus, however, there has been such a drawback that no consideration is given to a counter-measure when a trouble occurs and reduction in driving force in the working oil feeding pump. Namely, in the former case, since there is provided only one set of working oil feeding pump, feeding of the working oil is stopped when a piston and a cylinder of the pump stick together, and equipments driven by the working oil become inoperable, and in its turn an engine has to be suspended. Further, in the latter case, the working oil feeding pump always discharges the working oil at a consumption quantity and more of the high pressure oil apparatus and the working oil pressure is controlled by a pressure regulating valve. Therefore, the driving force of the working oil feeding pump is at a required quantity and more, thus producing a big power loss. Furthermore, only an accumulator is provided as a counter-measure against discharge pressure fluctuation of the working oil and no consideration is given to the feeding pump.

On the other hand, a conventional oil pressure control system for a fuel injector, an exhaust valve and the like which are driven by oil pressure is described in Japanese Patent Application Laid-Open No.59-176412(No.176412/1984) for instance. As shown in Fig. 11, this system is provided with a fuel feeding device S having a fuel feeding pump 69 which is driven by an internal combustion engine 68, a working oil feeding device P having a working oil pump 76 which is driven by the internal combustion engine, an injector device T having an injector 32 which pressurizes the fuel oil which is sent by pressure from the fuel feeding device S by means of an oil pressure servo mechanism 33 and injects the fuel oil from a nozzle valve 2 and a solenoid valve portion 31 which actuates the oil pressure servo mechanism 33 so as to control communication of the working oil, a valve device X consisting of a valve mechanism portion 62 which drives an exhaust valve 36 to open and close with oil pressure and a valve drive unit 61 having a solenoid valve portion 63 which actuates the valve mechanism portion 62 so as to control communication of the working oil, and a controller R having a computer 65 which controls a solenoid coil 12 of the solenoid valve portion 31 of the injector device T and a solenoid coil 48 of a solenoid valve portion 63 of the valve device X appropriately in accordance with the operating state of the internal combustion engine 68, and it is constructed so that the working oil is fed to the injector device T and the valve device X from the working oil feeding device P and the valve device X.

In a conventional oil pressure control system, however, the working oil pump 76 always discharges a constant quantity of high pressure working oil, and the discharge pressure is regulated by releasing the discharge oil by means of a pressure regulating valve 75, thus producing big loss in the driving power. Further, the fuel injector device T is composed as one body of the injector portion 32, the oil pressure servo mechanism 33 and the solenoid valve 31, and the structure thereof is complicated. Furthermore, the injector device T has to be replaced entirely even in case a trouble happens even at any one location. Therefore, not only economical disadvantages are caused, but also deterioration of the working oil is not avoidable because the working oil and the fuel oil are existent in a mixed state in the injector device T.

Further, the valve device X is composed of the valve mechanism portion 62, the solenoid valve portion 63 and the valve drive unit 61 as one body. Thus, there have been such problems that the structure is complicated and the valve device X has to be replaced entirely even if a trouble occurs at any one place, which is uneconomical, and moreover, consumption of the working oil is large and the loss of the driving power of the working oil pump 76 is also big since the valve drive device 61 is composed of a single piston.

3. OBJECT AND SUMMARY OF THE INVENTION

It is an object of the present invention which has been made in view of such points to provide a high pressure oil generating apparatus of an internal combustion engine in which above-described problems of a conventional apparatus are solved, the oil feeding quantity of a working oil pump may be matched surely to the use quantity, power loss is small, and oil pressure fluctuation is small.

It is another object of the present invention to provide a highly economical high pressure oil generating apparatus of an internal combustion engine in which above-described problems of a conventional apparatus are solved, the structure is simple and troubles occur less, only the minimal parts exchange is required in

case a trouble occurs, working oil consumption is small, driving power loss of a working oil pump is reduced, and fuel oil is prevented from mixing into the working oil so as to eliminate deterioration.

The epitome of the present invention for achieving above-mentioned objects is as stated in the following items (1) and (2) in a high pressure oil generating apparatus of an internal combustion engine for driving valves or devices installed in the internal combustion engine with hydraulic oil.

(1) A high pressure oil generating apparatus of an internal combustion engine according to the present invention comprises a cam having one and more lobes fixed to a crank shaft as one body, one and more jerk type high pressure pumps operated by the cam, a working oil source for feeding working oil to the high pressure pumps, an accumulator or a gathering pipe for accumulating high pressure working oil discharged from respective high pressure pumps, and a controller which detects working oil pressure in the accumulator or the gathering pipe and adjusts rack positions of respective high pressure pumps based on deviation thereof from a predetermined pressure so as to control the working oil pressure at the predetermined pressure. Here, it is preferable to provide the high pressure pumps at equal intervals around the cam.

As to the operation of a high pressure oil generating apparatus of the present invention, since a jerk type fuel injection pump having sufficient application results as a high pressure pump is utilized and a plurality of these pumps are used, the working oil will never be stopped to be fed by means of other pumps in case one set of plunger and barrel stick together and restoration to the original state can be made by replacing a stuck high pressure pump. Thus, it is not required to suspend the engine completely even when a trouble occurs in the pump in a part.

The working oil discharge number of times from the high pressure pumps in one revolution is expressed by the product of the number of high pressure pump sets and the number of cam lobes, and the construction is such that the number of discharge times is increased and the arrangement of high pressure pumps is made to have an optimum pitch with respect to the number of high pressure pumps and the number of cam lobes so that discharge interval becomes identical. As a result, it is possible to decrease the number of high pressure pumps thereby to thin out related pumps so that discharge oil pressure fluctuation becomes less, and the volume of the gathering pipe can be reduced. Furthermore, since the oil pressure in the gathering pipe is detected and the discharge quantity of the high pressure pump is controlled through the pump rack based on the deviation from a predetermined pressure so that the working oil is discharged by the quantity corresponding to the consumption quantity, there is an advantage that the loss of driving power of the high pressure pump may be made small.

The present invention being constructed as described above, such effects are obtainable that driving loss of high pressure pumps is eliminated, discharge pressure fluctuation of the high pressure pumps may be made small, the volume of an accumulator or a gathering pipe may also be reduced, high safety may be achieved because a plurality of high pressure pumps are installed, and suspension of feeding working oil may be prevented.

(2) A high pressure oil generating apparatus of an internal combustion engine according to the present invention comprises a cam having one and more lobes fixed to a crank shaft as one body, one and more jerk type high pressure pumps operated by the cam, a working oil source for feeding working oil to the high pressure pumps, an accumulator or a gathering pipe for accumulating high pressure working oil discharged from respective high pressure pumps, and a controller which detects working oil pressure in the accumulator or the gathering pipe and adjusts rack positions of respective high pressure pumps based on deviation thereof from a predetermined pressure so as to control the working oil pressure at the predetermined pressure, a crank angle detector, an oil pressure driven fuel injector, a switching valve provided between a pressure chamber of the fuel injector and above-mentioned accumulator or gathering pipe, and a controller which opens and closes the switching valve at a predetermined timing based on a signal of the crank angle detector.

Further, a high pressure oil generating apparatus of the present invention comprises an oil pressure driven valve device, a switching valve provided between a pressure chamber of the valve device and above-mentioned accumulator or gathering pipe and a controller which opens and closes the switching valve at a predetermined timing based on a signal of the crank angle detector.

Furthermore, a high pressure oil generating apparatus comprises a starting booster which feeds high pressure working oil to above-mentioned accumulator or gathering pipe in addition to above-mentioned construction.

As to the operation of the present invention, a valve actuator M being composed of two stages, a large diameter piston for opening an exhaust valve and a small diameter piston for maintaining lift, consumption of the working oil is small. Further, the discharge quantity of the high pressure working oil pump is controlled by the controller through the valve actuator so as to discharge only a required quantity

corresponding to a set pressure of the accumulator. Therefore, the driving power of the high pressure working oil pump can be reduced by a large margin, which is advantageous economically. Furthermore, since a plurality of high pressure working oil pumps are provided, the pump may be replaced individually even during operation and it is not required to suspend the engine.

Further, the fuel injector is separated independently into a fuel regulating valve, a fuel pressurizer and a fuel valve. Therefore, parts to be repaired or to be replaced against individual trouble are small in number. Thus, the apparatus is economical, and is able to prevent the fuel oil from mixing into the working oil before it happens.

Furthermore, the exhaust valve device is also separated independently into a valve regulating valve and a valve actuator, and parts to be repaired or to be replaced against individual trouble are small in number, which is economical.

Moreover, starting can be performed surely and easily because the high pressure working oil flows into an accumulator C from a starting booster at the time of starting.

The present invention being composed as described above, such effects are obtained that consumption of accumulated working oil may be reduced to the irreducible minimum of the demand, thus eliminating driving power of a high pressure working oil pump. Furthermore, repair and parts replacement to the irreducible minimum of the demand may be performed without suspension of an engine by separating composition of equipments independently, and it is also possible to avoid deterioration of working oil by preventing fuel oil from mixing into the working oil, and to prevent accidents from occurring by suspending fuel injection in a cylinder after defective operation of the discharge valve occurs.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 thru Fig. 5 show a first embodiment of the present invention, wherein:

Fig. 1 is a structural view of a rear end portion of an engine (taken along a line I-I in Fig. 2);

Fig. 2 (a) is a perspective view seen in a direction shown at IIa in Fig. 1;

Fig. 2 (b) is a sectional view taken along a line II_b-II_b in Fig. 1;

Fig. 3 is a sectional view of a high pressure pump;

Fig. 4 is an explanatory view of pressure fluctuation; and

Fig. 5 shows explanatory diagrams for explaining pump arrangement and discharge interval.

Fig. 6 thru Fig. 10 show a second embodiment of the present invention, wherein:

Fig. 6 shows general structural views of an oil pressure control system;

Fig. 7 is a detailed view of a valve regulating valve F shown in Fig. 6;

Fig. 8 is a detailed view of a fuel regulating valve shown in Fig. 6;

Fig. 9 is a perspective view seen in a direction shown at IX in Fig. 6, which shows an arrangement example of high pressure working oil pumps;

Fig. 10 is a sectional view of a high pressure working oil pump; and

Fig. 11 is a general structural view of a conventional oil pressure control system.

5. DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the present invention will be described in detail hereafter with reference to the accompanying drawings.

The first embodiment:

An embodiment of the present invention will be described hereafter with reference to Figs. 1 to 5.

Fig. 1 is a structural view of a rear end portion of an engine, which is a sectional view taken along a line I-I in Fig. 2, Fig. 2 (a) is a perspective view seen in a direction shown at II_a in Fig. 1, and Fig. 2 (b) is a sectional view taken along a line II_b-II_b in Fig. 1 showing a general structural view of a high pressure oil generating apparatus.

In these Figures, a numeral 1 denotes a crank shaft, 2 denotes a thrust collar formed with the crank shaft 1 as one body, 3 denotes a plurality of thrust pads which form a thrust bearing which receives the thrust collar 2 and moves forward and rearward, 4 denotes a cam which has a plurality of lobes 4a fastened to the outer periphery of the thrust collar 2 through a key 5 as one body with bolts and is divided into halves, and 6 denotes a journal bearing which receives the crank shaft 1. 7 denotes a fitting base fastened with bolts to an engine body 8, 9 denotes a high pressure pump fastened with bolts to the fitting base 7 through a pump cradle 10, 11 denotes a roller fitted rotatably to a slide cylinder 13 through a pin 12, and

the slide cylinder 13 is guided slidably up and down on the fitting base 7 and the pump cradle 10 and the upper end thereof abuts against a plunger of the high pressure pump 9.

A spring 14 presses the roller 11 against the cam 4 through the pin 12. A plurality of high pressure pumps 9 are arranged radially at a pitch θ, and pump racks 9a of respective high pressure pumps 9 are joined with each other and one end thereof is coupled with an actuator 15, and the discharge quantity of these high pressure pumps is controlled through feedback by means of a controller 16 so that the pressure of a gathering pipe 17 becomes a set value. In Fig. 2, the high pressure pump 9 shown with a broken line shows a case in which the number of pumps is reduced in an engine having a small number of cylinders, and is shielded with a cover 18. The high pressure pump 9 has a low pressure oil gateway 19, and the low pressure oil is fed from a tank 20 by a motor-driven oil pump 22 through a filter 21, and circulates in the high pressure pump, and the oil pressure is regulated by a pressure regulating valve 23. The filter 21 and the oil pump 22 are provided against emergency.

Fig. 3 is a sectional view showing a jerk type high pressure pump. A plunger 30 is guided slidably along a plunger barrel 32 having an oil filler port 32a fixed to the body 31. The plunger 30 is pressed against the slide cylinder 13 at the lower portion thereof by means of a spring 33, moves vertically by the cam 4, rotates the plunger 30 through a sleeve 34 by the pump rack 9a and changes the position of a lead 35 so as to control the discharge quantity of the high pressure pump 9. A discharge valve 38 which is fastened with a bolt 39 through a cap metal fittings 36 and pressed downward by a spring 37 is provided in an upper part of a barrel 32, and 40 indicates a high pressure oil outlet.

In the next place, the operation of the present embodiment will be described.

Since a plurality of high pressure pumps 9 are installed, the high pressure oil is continued to be fed even when one set of pump sticks if other pumps are in a normal state, thus making it possible to repair and restore the high pressure pump without suspending the engine. The number of discharge times Y of the high pressure pump 9 per one revolution of the engine is expressed by the product of the number N of the high pressure pumps 9 and the number Z of the lobes of the cam 4 as shown in the following expression.

$$Y = N \times Z \qquad (1)$$

Here, the coefficient of pressure fluctuation Δ_p of the high pressure oil produced by the discharge of the working oil is determined by the coefficient of flow rate fluctuation Δ_q of the discharge, and Δ_q is expressed by the number of discharge times Y as shown in Fig. 4. Fig. 4 shows discharge at equal intervals, and the pressure fluctuation becomes the minimal in the case of equal intervals.

Next, an example at equal intervals in the present invention will be explained with reference to Fig. 5. When it is assumed that the number of lobes of the cam is Z and the number of high pressure pumps is N, the interval θ (degrees) of high pressure pump arrangement is expressed as:

$$\theta = \frac{360}{Z \cdot N} \qquad \ldots \quad (2)$$

Namely, Fig. 5 shows a high pressure pump arrangement drawing (upper drawing) and a high pressure pump discharge interval drawing (lower drawing) when the number of lobes of the cam is 4, and the number of high pressure pumps is 4 in Fig. 5 (a), 3 in Fig. 5 (b) and 2 in Fig. 5 (c) (the number of high pressure pumps is increased and decreased in accordance with the number of cylinders).

When description is made in detail with Fig. 5 (a) as an example, $360^\circ/4 = 90^\circ$ is considered as one unit in case the number of lobes of the cam is 4, and high pressure pump are arranged (shown at positions shown with O in the upper drawing) at every interval θ_1 (degrees) obtained by dividing 90° by the number of high pressure pumps.

In the case of Fig. 5 (c), the configuration shows that high pressure pumps shown in Fig. 5 (a) are thinned out, and thus common elements such as a fitting base shown in Fig. 5 (a) may be used. Accordingly, commonness may be planned, thus curtailing the cost.

Further, in the case of Fig. 5, it is possible to thin out one set of high pressure pump shown in Fig. 5 (a) for a 5-6 cylinder engine (though no longer at equal intervals). Therefore, further cost reduction may be expected by common use of parts.

Besides, it is needless to say that $360^\circ/3 = 120^\circ$ or $360^\circ/5 = 72^\circ$ is adopted as one unit when the number of lobes of the cam is 3 or 5.

Furthermore, since the controller 16 controls one end of the rack 9a through the actuator 15 so that the

deviation becomes zero by comparing a set pressure and a detected pressure in the gathering pipe 17, the high pressure pump 9 feeds the working oil in the quantity corresponding to the consumption quantity, and the driving loss of the high pressure pumps is small.

The second embodiment:

Another embodiment of the present invention will be described hereafter with reference to Figs. 6 to 10.

Fig. 6 is a general structural view of an electronic oil pressure control system of a high pressure oil generating apparatus, Fig. 7 is a structural view of a valve regulating valve in Fig. 6, Fig. 8 is a structural view of a fuel regulating valve in Fig. 6, Fig. 9 is a perspective view seen in a direction shown at IX in Fig. 6 showing an arrangement diagram of high pressure working oil pumps, and Fig. 10 is a sectional view of a jerk type high pressure hydraulic oil pump.

In Fig. 6, A indicates an oil pressure source consisting of a plurality of high pressure working oil pumps A4 which are driven by a multi-lobe cam A2 fixed as one body on an outer periphery of a thrust collar A1 at a rear portion of a crank shaft through a roller A3. Incidentally, low pressure working oil is fed with circulation to the oil pressure source A from a working oil feeding source B consisting of a filter B1, an electric pump B2, a pressure regulating valve B3 and a tank B4. C indicates an accumulator which accumulates high pressure working oil which has been fed with pressure from the oil pressure source A, and D indicates a fuel regulating valve which consists of an injection starting logic valve D2 and an injection terminating logic valve D3 which are opened and closed through working oil by means of a 5-way electromagnetic valve D1 controlled by a controller E. F indicates a valve regulating valve, which includes a valve opening logic valves F3 and a valve opening logic valve F4 which are opened and closed through working oil by means of 3-way electromagnetic valves F1 and F2. G indicates a fuel pressurizer, which is fixed to a body G1 and includes a barrel G3 for guiding a plunger G2, a pump rack G4 which rotates the plunger G2 and regulates discharge quantity of high pressure fuel oil, a spring G5 which energizes the plunger G2 downward, an injection pump G10 having a discharge valve G6, and a piston G8 guided by a cylinder G7 which receives working oil controlled by the fuel regulating valve D and drives the injection pump G10. Low pressure fuel oil is fed with circulation to the injection pump G10 from a fuel feeding source H consisting of a filter H1, an electric pump H2, a pressure regulating valve H3 and a tank H4. The fuel oil pressurized to a high pressure is injected into a cylinder not shown by means of the injection pump G10 from a plurality of fuel valves L through a high pressure pipe J and a branching metal mountings K.

M indicates a valve actuator and is composed of a two-stage piston M3 guided by a cylinder M2 fixed to a body M1 and a check valve M4. The two-stage piston M3 has a small diameter piston M3a and a large diameter piston M3b, and the cylinder M2 has a small diameter piston feeding hole M2a and a large diameter piston feeding hole M2b. Further, the valve actuator M has the two-stage piston M3 and oil cushions M6 and M5 at upper and lower moving ends. N indicates an exhaust valve, which is fixed to a cylinder cover N1 and consists of a valve rod guide N3 which guides a valve rod N2 and an air spring N4, and the air spring N4 is fed with air from a guide tank N5. P indicates a starting booster, which receives low pressure working oil from the working oil feeding source B and sends with pressure high pressure working oil to the accumulator C temporarily at the time of starting an engine based on an instruction of the controller E. A5 indicates an actuator, in which discharge quantity of the high pressure working oil pump A4 is controlled by means of the controller E with a signal of a pressure detector C1 so that the pressure in the accumulator becomes a set pressure. A6 indicates a crank angle detector, which outputs a signal for the controller E to control the 5-way electromagnetic valve D1 and 3-way electromagnetic valves F1 and F2. Z indicates an operation detector of the exhaust valve N and outputs a signal notifying of defective operation of the exhaust valve to the controller E.

Fig. 7 shows a concrete construction of a valve opening logic valve F3, a valve closing logic valve F4 and 3-way electromagnetic valves F1 and F2, and Fig. 8 shows a concrete construction of an injection starting logic valve D2, an injection terminating logic valve D3, a 5-way electromagnetic valve D1 and an accumulator C. Fig. 9 is an arrangement drawing of high pressure working oil pumps A4. Fig. 10 shows a jerk type high pressure fuel pump, in which A4a denotes a body, A4b denotes a barrel, A4c denotes a plunger guided by the barrel A4b, A4d denotes a pump rack which regulates discharge quantity by rotating the plunger A4c, A4e denotes a spring which energizes the plunger A4c downward, and A4f denotes a discharge valve.

Next, the operation of above-mentioned embodiment will be described.

In Fig. 9, the working oil is fed to high pressure working oil pumps A4 under low pressure from the working oil feeding source B and pressurized by the high pressure working oil pumps A4 during engine operation, and the working oil is pressurized temporarily by means of a starting booster P and accumulated

in the accumulator C. The controller E controls pump racks A4d of high pressure working oil pumps A4 through an actuator A5 based on a signal of a pressure detector C1 so that the accumulator pressure becomes a set value, and regulates the discharge quantity of high pressure working oil pumps A4 to a required quantity. The accumulated oil is controlled by the fuel regulating valve D in accordance with an instruction of the controller E based on a signal of a crank angle detector 6 and is fed to a fuel pressurizer G by the injection starting logic valve D2 at the time of fuel injection, and has the piston G8 stroke. Feeding is suspended at the completion of stroke of the piston G8 corresponding to the fuel injection quantity. The working oil fed to the fuel pressurizer G is discharged by the injection terminating logic valve D3, and the piston G8 returns to the initial position by the urging force of a spring G5. The injection pump G10 pressurizes the fuel oil fed from a fuel feeding source H under a low pressure by upward movement of the piston G8 and injects it into a cylinder not shown from fuel valves L through a high pressure pipe J and a branching metal mounting K. Further, the injection pump G10 makes the injection quantity zero through an actuator G9 so as to sustain the engine by means of the controller E of the pump racks G4 and an independent device not shown upon an abnormal state of the controller E. Incidentally, the following methods of checking abnormal state may be considered.

① When there is no input/output because of disconnection of the controller, checking is possible by monitoring input/output signals.

② When an input/output signal of the controller shows an abnormal value, checking may be made in such a manner that an appropriate range is predetermined and an input/output signals are monitored so as to find whether these signals are off the appropriate range.

③ When a driver of a switching valve becomes inoperative, checking may be made by monitoring the operation of the switching valve with a sensor.

The valve regulating valve F controls the accumulated oil in accordance with an instruction of the controller E based on a signal of the crank angle detector A6. The accumulated oil is fed to the valve actuator M by the valve opening logic valve F3 at the time of opening the exhaust valve so as to have an exhaust valve N stroke, and the stroke is suspended after completion of required strokes. The working oil in the valve actuator M is discharged by the valve closing logic valve F4 at the time of closing the exhaust valve, and the two-stage piston M3 is returned to the initial position by the energizing force of the air spring N4, thus completing the operation of the exhaust valve N. When an exhaust valve having a large resistance of the exhaust valve N is opened, the accumulated oil is fed to a small diameter piston M3a from a check valve M4 and fed to a large diameter piston M3b through a large diameter piston feeding hole M2b, thereby to consume a large flow quantity. However, when the two-stage piston M3 strokes until the time when the resistance of the exhaust valve N becomes small, the accumulated oil is fed to a small diameter piston also through a large diameter piston feeding hole M2b, thus reducing consumption of the accumulated oil. Further, the movement of the two-stage piston M3 is relieved by means of oil cushions M5 and M6 at upper and lower ends of the stroke, thereby to prevent mechanical collision. When defective operation of the exhaust valve N is detected by the operation detector Z which checks light quantity of a gap sensor and the like, the injection quantity of fuel injection thereafter in the cylinder is made zero by means of a device not shown which makes the pump rack G4 independent of the controller E so as to suspend the engine, thereby to prevent accident from occurring.

Claims

1. A high pressure oil generating apparatus of an internal combustion engine for driving valves or devices and the like installed in the internal combustion engine with working oil, comprising:
   a cam having one and more lobes fixed to a crank shaft of said engine as one body;
   one and more jerk type high pressure pumps operated by said cam;
   a working oil source for feeding working oil to said high pressure pumps;
   an accumulator or a gathering pipe for accumulating high pressure working oil discharged from respective high pressure pumps; and
   a control means which detects working oil pressure in said accumulator or gathering pipe and adjusts rack positions of said respective high pressure pumps based on deviation thereof from a predetermined pressure so as to control said working oil pressure at said predetermined pressure.

2. A high pressure oil generating apparatus of an internal combustion engine according to Claim 1, characterized in that said high pressure pumps are arranged at equal intervals around said cam.

3. A high pressure oil generating apparatus of an internal combustion engine for driving valves or devices

and the like installed in the internal combustion engine with working oil, comprising:

a cam having one and more lobes fixed to a crank shaft of said engine as one body,

one and more jerk type high pressure pumps operated by said cam;

a working oil source for feeding working oil to said high pressure pumps;

an accumulator or a gathering pipe for accumulating high pressure working oil discharged from respective high pressure pumps;

a control means which detects working oil pressure in said accumulator or gathering pipe and adjusts rack positions of said respective high pressure pumps based on deviation thereof from a predetermined pressure so as to control said working oil pressure at said predetermined pressure;

a crank angle detector;

an oil pressure driven fuel injector;

a switching valve provided between a pressure chamber of said fuel injector and said accumulator or gathering pipe; and

a control means which opens and closes said switching valve at a predetermined timing based on a signal of said crank angle detector.

4. A high pressure oil generating apparatus of an internal combustion engine according to Claim 3, comprising a starting booster which feeds high pressure working oil to said accumulator or gathering pipe.

5. A high pressure oil generating apparatus of an internal combustion engine for driving valves or devices and the like installed in the internal combustion engine with working oil, comprising:

a cam having one and more lobes fixed to a crank shaft of said engine as one body;

one and more jerk type high pressure pumps operated by said cam;

a working oil source for feeding working oil to said high pressure pumps;

an accumulator or a gathering pipe for accumulating high pressure working oil discharged from respective high pressure pumps;

a control means which detects working oil pressure in said accumulator or gathering pipe and adjusts rack positions of said respective high pressure pumps based on deviation thereof from a predetermined pressure so as to control said working oil pressure at said predetermined pressure,

a crank angle detector;

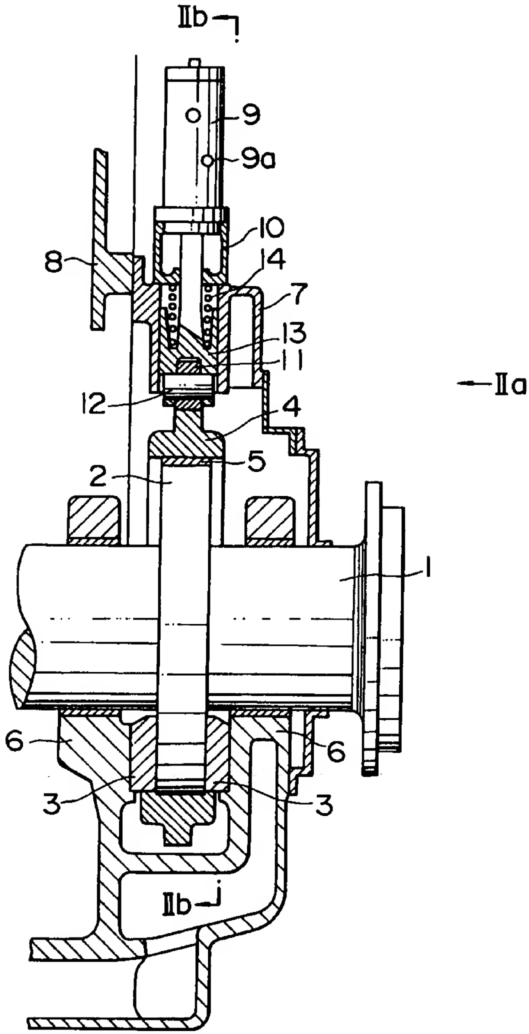
an oil pressure driven valve device;

a switching valve provided between a pressure chamber of said valve device and said accumulator or gathering pipe; and

a control means which opens and closes said switching valve at a predetermined timing based on a signal of said crank angle detector.

6. A high pressure oil generating apparatus of an internal combustion engine according to Claim 5, comprising a starting booster which feeds high pressure working oil to said accumulator or gathering pipe.

F I G. 1



F I G. 2

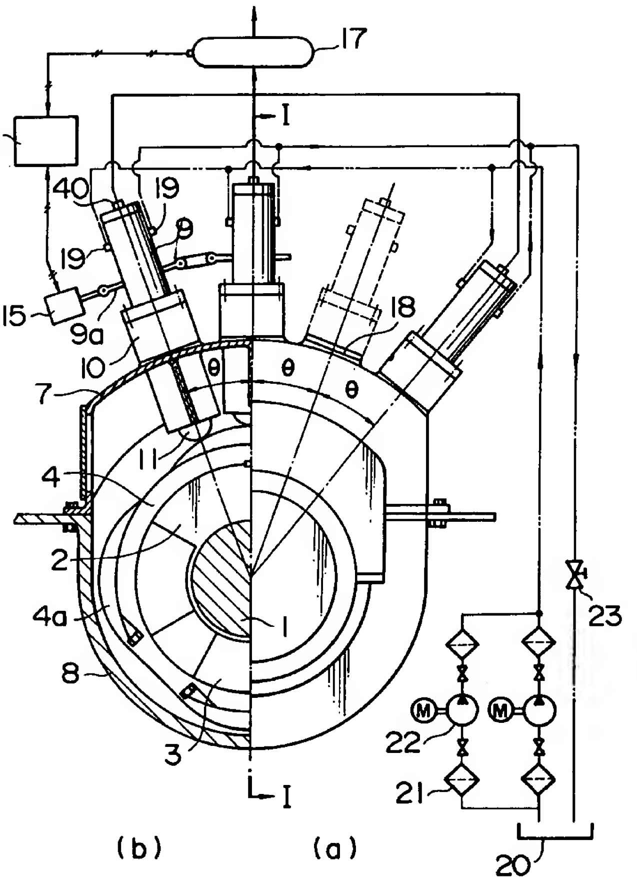


FIG. 3

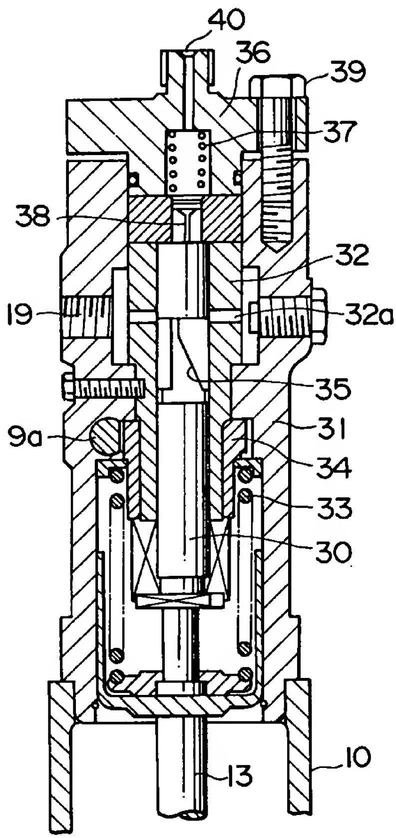
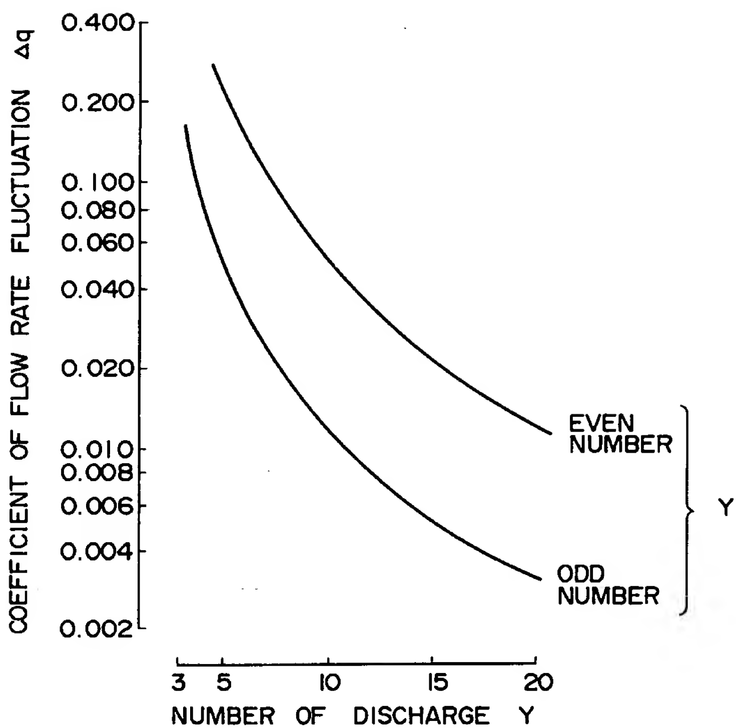


FIG. 4


COEFFICIENT OF FLOW RATE FLUCTUATION Δq
0.400
0.200
0.100
0.080
0.060
0.040
0.020
0.010
0.008
0.006
0.004
0.002
EVEN NUMBER
ODD NUMBER
Y
3
5
10
15
20
NUMBER OF DISCHARGE Y

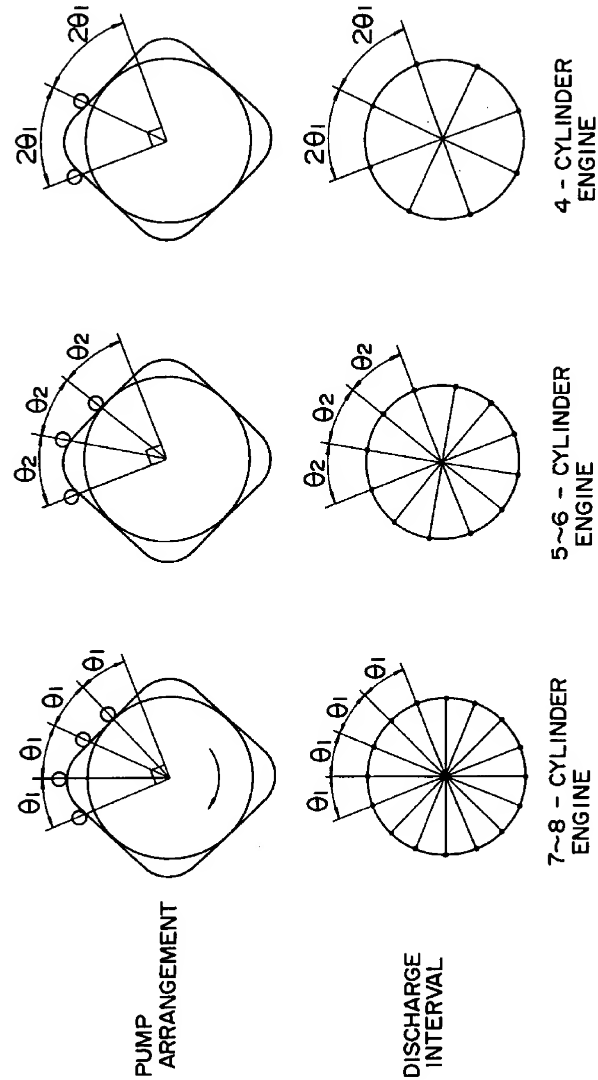
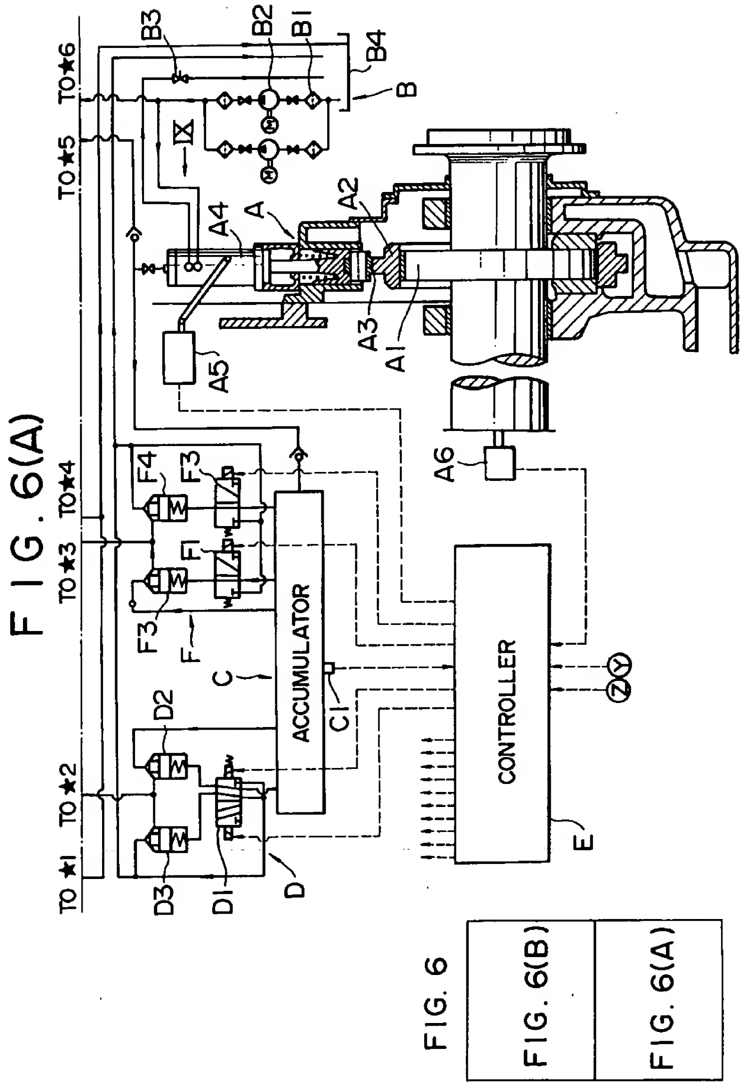


FIG. 5(a)

FIG. 5(b)

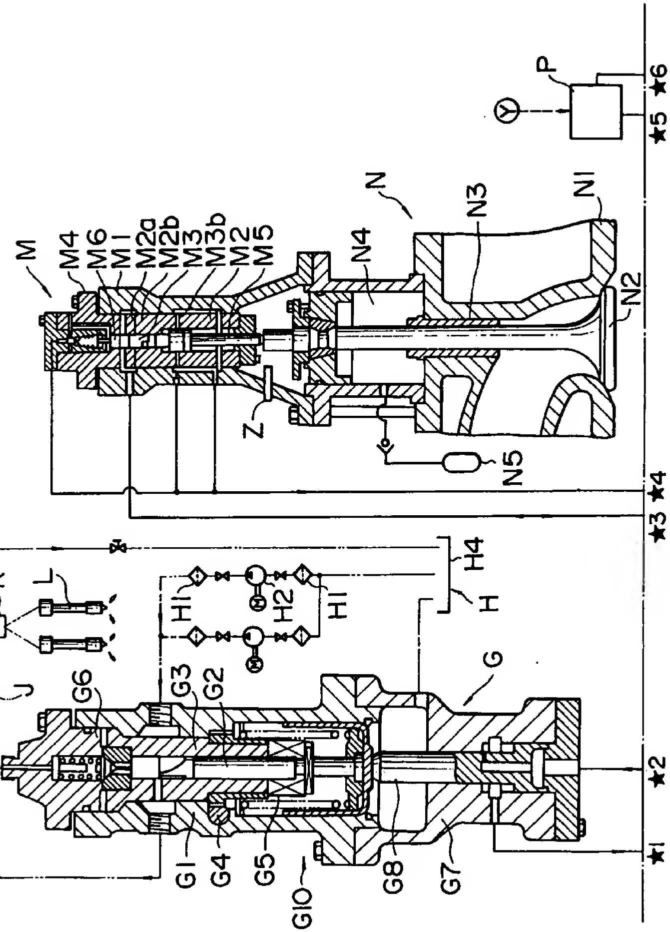
FIG. 5(c)


TO ★1
TO ★2
TO ★3
TO ★4
TO ★5
TO ★6
B3
B2
B1
B4
B
A4
A
A2
A3
A1
A5
A6
F4
F3
F1
F3
F
C
ACCUMULATOR
C1
D2
D3
D1
D
CONTROLLER
E
Z
Y
FIG. 6(B)
FIG. 6(A)

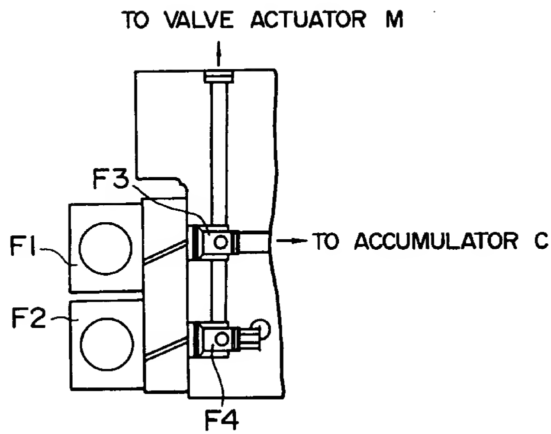
F I G. 6(A)

FIG. 6

F I G. 6(B)


M
M4
M6
M1
M2a
M2b
M3
M3b
M2
M5
N
N4
N3
N1
N2
Z
N5
P
Y
★1
★2
★3
★4
★5
★6
K
L
J
G6
G3
G2
G
G1
G4
G5
G10
G8
G7
H1
H2
H4
H

F I G. 7


TO VALVE ACTUATOR M
F3
F1
F2
TO ACCUMULATOR C
F4

F I G. 8

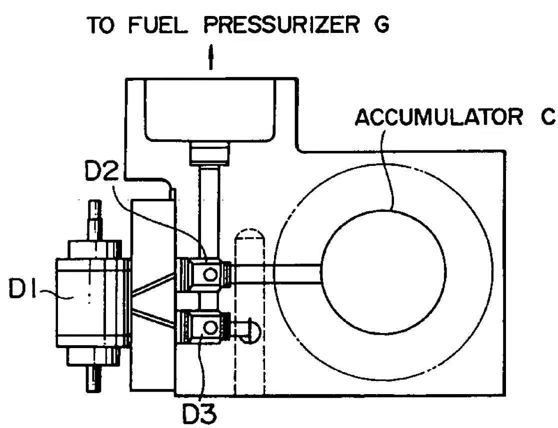
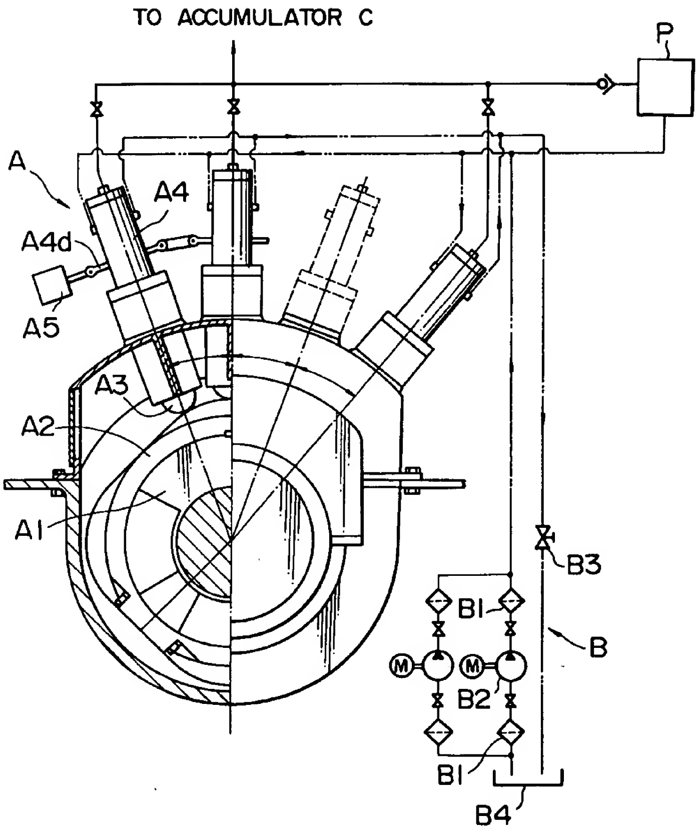

TO FUEL PRESSURIZER G
ACCUMULATOR C
D2
D1
D3

FIG. 9



F I G. 10

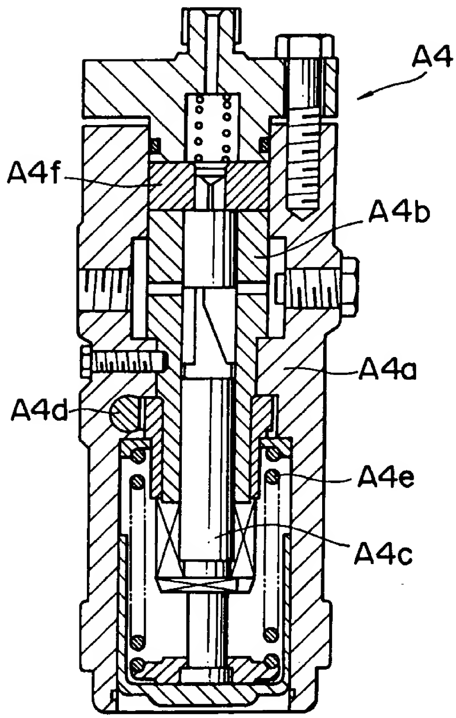
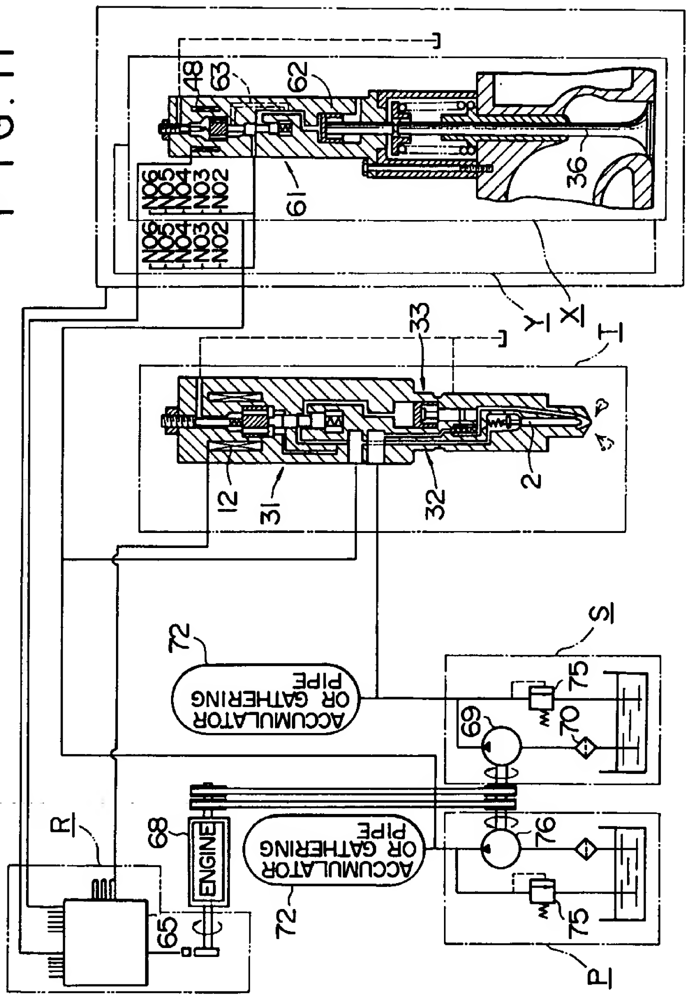


FIG. 11


ENGINE
ACCUMULATOR OR GATHERING PIPE
ACCUMULATOR OR GATHERING PIPE
NO6
NO5
NO4
NO3
NO2
R
S
P
T
X
Y
2
12
31
32
33
36
48
61
62
63
65
68
69
70
72
75
76